SCIENCE, AERONAUTICS, AND TECHNOLOGY APPROPRIATION

LIFE AND MICROGRAVITY SCIENCES & APPLICATIONS

FY 2001 CONGRESSIONAL BUDGET ESTIMATE

SUMMARY OF RESOURCE REQUIREMENTS

	FY 1999 OPLAN 12/23/99	FY 2000 OPLAN REVISED	FY 2001 PRES BUDGET	Page Number
		(Thousands of Dollars)		
Advanced Human Support Technology (AHST)	24,500	30,215	30,900	SAT 2-7
Biomedical Research & Countermeasures (BR&C)	59,700	57,192	76,900	SAT 2-10
[Construction of facilities]	[3,500]	[9,000]	[8,500]	
Fundamental Biology (FB)				SAT 2-13
(Formerly Gravitational Biology and Ecology (GB&E))	40,900	38,200	39,200	
Microgravity Research (MR)	113,700	108,800	129,260	SAT 2-15
Space Product Development (SPD)	15,400	14,400	13,600	SAT 2-19
Health Research (HR)	7,600	8,700	11,300	SAT 2-23
(Formerly Occupational Health Research (OHR) and Space Medicine Research (SMR))				
Mission Integration (MI)	1,700	17,214	240	SAT 2-28
Investments (MURED from BR&C in FY 1999 and in FY 2000)	[1,000]	[1,000]	1,000	SAT 2-31
Total	263,500	274,721	302,400	
Distribution of Program Amount by Installation				
Johnson Space Center (JSC)	76,999	94,458	124,109	
Kennedy Space Center (KSC)	5,808	5,465	4,559	
Marshall Space Flight Center (MSFC)	63,613	53,163	61,387	
Ames Research Center (ARC)	34,099	32,651	36,185	
Langley Research Center (LaRC)	429	52	35	
Glenn Research Center (GRC)	38,891	39,377	37,348	
Goddard Space Flight Center (GSFC)	11,069	10,324	6,776	
Jet Propulsion Laboratory (JPL)	12,881	10,484	13,988	
Headquarters (HQs)	19,711	28,747	18,013	
Total	263,500	274,721	302,400	

GENERAL

The Life and Microgravity Sciences and Applications (LMSA) program is an integral component of NASA's Human Exploration and Development of Space (HEDS) Enterprise. The projects supported by the LMSA program through ground- and space-based basic and applied research, seek to advance scientific and commercial knowledge, to enable the development of space for human enterprise, to create new products and services through space research, and to transfer the knowledge and technologies developed as broadly as possible within the United States. We seek to enable and exploit the possibilities of human space flight to improve the quality of life for people on Earth.

PROGRAM GOALS

The Office of Life and Microgravity Sciences and Applications (OLMSA) plays a primary role in the pursuit of the following goals and objectives of HEDS and a secondary role in the pursuit of other HEDS goals. OLMSA provides key products for the following five general goals of the enterprise.

Goal: Expand the Frontier.

Objective- Enable human exploration through collaborative robotic missions.

Goal: Expand Scientific Knowledge.

Objective – Investigate chemical, biological and physical systems in the space environment, in partnership with the scientific community.

Goal: Enable and establish permanent and productive human presence in Earth orbit.

Objective – Ensure the health, safety and performance of humans living and working in space.

Goal: Expand commercial development of Space.

Objective –Facilitate access to space for commercial researchers.
Objective – Foster commercial participation on the International Space Station.

Goal: Share the experience and discovery of human Space flight.

Objective – Advance the scientific, technological and academic achievement of the Nation by sharing our knowledge, capabilities and assets.

Outcomes:

OLMSA seeks to advance scientific knowledge, to enable the development of space for human enterprise, and to transfer the knowledge and technologies that we develop as broadly as possible. We seek to enable and exploit the possibilities of human space flight and to improve the quality of life for people on Earth. Among the ultimate outcomes of our work are:

expanded fundamental knowledge;
improved health and human performance on earth and in space;
improved industrial processes;
expanded commercial activity in space; and
enhanced capabilities for humans to live, work and explore in space.

STRATEGY FOR ACHIEVING GOALS

OLMSA pursues the goals described above through the following projects, which focus on specific fields of research:

Advanced Human Support Technology (AHST)
- Provides cutting edge technologies for the support of humans in space.

Biomedical Research and Countermeasures (BR&C)
- Contributes to the health, safety and performance of space crews.
- Investigates the biomedical effects of space flight to provide the biomedical bases for future human exploration and development of space.

Fundamental Biology (FB) (formerly Gravitational Biology and Ecology (GB&E))
- Investigates the interaction between gravity and basic biological processes using living systems, ranging from simple cells to humans, in space and on the ground.

Microgravity Research (MR)
- Uses the environment of space to explore the nature of physical, chemical, and biological processes contributing to progress in science and technology on Earth.
- Studies the role of gravity in technological processes, building a scientific foundation for understanding the consequences of gravitational environments beyond Earth's boundaries.

Space Product Development (SPD)
- Facilitates the use of space for commercial products and services.
- Couples NASA and private sector technology development to the advantage of both.

Within each of these projects, OLMSA supports fundamental and applied research driven by an emphasis on expanding scientific and commercial knowledge and disseminating the research database as widely as possible to the American research and technology and commercial communities. Mission-driven research improves knowledge and technology for human space flight and exploration. Applications-driven research seeks to increase industrial involvement and transfer knowledge, expertise and technology to an appropriate partner or partners.

In addition, OLMSA is an operational organization conducting the following functions:

Health Research (HR)

- Space Medicine Research (SMR)
  - Ensures the delivery of clinical care in support of human space flight.
  - Establishes requirements for medical care and medical research to support human space flight.
- Occupational Health Research (OHR)
  - Contributes to the health, well being, safety, and productivity of the NASA workforce.

Mission Integration (MI)

- Integrates research missions involving human space flight.

OLMSA's program of research and technology development relies upon broad participation by researchers from academia, other government agencies and departments, nonprofit and commercial sectors, NASA's Commercial Space Centers (CSCs), NASA Specialized Centers for Research and Technology, and NASA Field Centers. In selecting investigations and projects for support, and ultimately for access to space, OLMSA follows different, but closely related processes for scientific research, for commercial research, and for technology research and development.

OLMSA uses ground-based research to develop and refine concepts for space experiments and to create a framework of knowledge and expertise in which the full scientific value can be realized. It utilizes the nation's academic and industrial resources, joining prominent researchers with NASA expertise in multidisciplinary microgravity experimentation. In support of the science community, the program also finances unique gravitational simulation facilities such as centrifuges, parabolic aircraft, drop towers/tubes, and other specialized support facilities and technologies such as chambers, bed rest studies, and data archiving. All non-commercial research is conducted on an open, competitive, peer-reviewed research solicitation process including the regular release of NASA Research Announcements (NRAs) in specific disciplines and reviews of proposals by independent panels of experts.

In addition to regular solicitations (NRAs), OLMSA is breaking new ground by fostering research in Biologically-Inspired Technology through dedicated NRAs. NASA has embarked on a focused program to develop advanced technologies that are critical for long duration space flights to monitor human health in a non-invasive manner. These advanced technologies are expected to confer significant benefits to medical care on Earth. Such biologically-inspired technologies will provide products which have features of biology embedded within them such as self-assembly, self-repair, fault tolerance, low energy needs and nanometers in feature size. The products from this research could have significant benefits on Earth, by enabling early detection of diseases. NASA is collaborating with the National Cancer Institute in this research and is actively seeking partnerships with other Federal Agencies to advance the field of nanotechnology.

Commercial research is supported through NASA-sponsored Commercial Space Centers' ground-based capabilities, as well as KC-135 aircraft for commercial research efforts that do not require extended duration microgravity. The Commercial Space Center ground and aircraft-based activities also support precursor research for the extended duration microgravity environment of Shuttle missions and the International Space Station. Commercial research initiatives are evaluated against established selection

criteria including leveraged commitment from the private sector, clear product development goals, technical feasibility, and a market assessment.

OLMSA implements its space-based research on robotic free-flying vehicles, Space Shuttle missions in which experiments use pressurized carriers (i.e. SpaceHab) and/or unpressurized carriers (i.e., IMPESS pallet, Hitchhiker, Get-Away-Special carriers, or other unique support structures) that fly in the cargo bay as well as the Shuttle Middeck for small payloads, and, in the future, on the ISS. OLMSA employs this array of flight platforms in support of the broader strategic goals enumerated above. OLMSA does not employ a separate research selection track for mission oriented research. It maintains a queue of worthy research, to manifest as opportunities become available.

Bioastronautics Initiative

An important element of the Administration's Science and Technology (S&T) Initiative is in the field of biomedical research with NASA. With increased funds from the S&T Initiative, OLMSA will enhance and integrate activities already underway, creating a Bioastronautics Initiative that will ensure the health, safety, and performance of humans in space by accelerating research and development of "countermeasures" (diagnostics, therapy, preventatives, and rehabilitation methods) to maintain the health of flight crews on long duration missions and transfer this knowledge and technology to benefit health on Earth. Bioastronautics research is an interdisciplinary set of focused research activities bringing together biology, physics, chemistry, communications technology and nano-technologies that will revolutionize medical care delivery in space and on Earth. This research will produce technologies that will benefit health care such as: non-invasive or minimally invasive diagnostic systems, autonomous medical care delivery systems including robotic surgical capabilities, environmental control systems that are human-centered, providing rapid feedback and by detecting microbial, toxic and other environmental hazards, wearable sensors allowing autonomy and mobility, and portable, light-weight, compact health-monitoring systems applicable to space or ground situations. NASA's need for ensuring human safety, health and performance in space serves as a forcing function in many of these important technological development areas. OLMSA is engaging other Federal agencies, private and academic sectors to partner with NASA to explore these exciting areas. These partnerships will leverage and accelerate NASA's investments, and will also ensure a rapid transfer of this technology to the private sector.

A significant portion of the Bioastronautics Initiative will support biomedical research and development work sponsored by the National Space Biomedical Research Institute (NSBRI). The Institute's current research program focuses on twelve areas – bone loss; cardiovascular alterations; human performance and sleep; immunology, infection and hematology; muscle changes; balance problems; radiation effects; technology development; neurobehavioral and psychosocial factors; nutrition, physical fitness and rehabilitation; smart medical systems; and integrated human function. The technology aspect of this program will rely on our cooperative activities in these disciplines working together with NIH and other organizations as appropriate to leverage resources, ensure technology transfer for health care, and enhance synergism. The OLMSA projects contributing to this Initiative are AHST, BR&C, MR and HR (SMR). NASA is currently evaluating options for and benefits of integrating facilities and capabilities where astronauts, medical professionals, scientists, engineers, and operational specialists could interact as a team in accomplishing this bioastronautics initiative.

FY 2001 Funding for Bioastronautics Initiative	FY 1999 OPLAN	FY 2000 OPLAN	FY 2001 PRES BUDGET

			(Thousands of Dollars)
Advanced Human Support Technology (AHST)	--	--	[2,000]
Biomedical Research & Countermeasures (BR&C)	--	--	[29,000]
Microgravity Research (MR).....	--	--	[11,000]
Health Research (HR) (formerly Occupational Health Research and Space Medicine Research (SMR))			[3,000]
Total Bioastronautics	--	--	[45,000]

BASIS OF FY 2001 FUNDING REQUIREMENT

ADVANCED HUMAN SUPPORT TECHNOLOGY

	FY 1999	FY 2000	FY 2001
	(Thousands of Dollars)		
Advanced Human Support Technology (AHST)	24,500	30,215	30,900

GOALS

The goals of AHST are: (1) to demonstrate and validate full self-sufficiency in air, water, and food recycling technology for use in space vehicles; (2) to demonstrate and validate integrated, fully autonomous environmental monitoring and control systems; and (3) to validate human factors engineering technology and protocols to ensure maintenance of high ground and flight crew skills during long-duration missions. AHST makes NASA technologies available to the private sector for Earth applications.

STRATEGY FOR ACHIEVING GOALS

AHST includes Advanced Life Support Systems (ALS), Space Human Factors (SHF), and Advanced Environmental Monitoring and Control (AEMC). ALS develops advanced regenerative life support technologies and systems by combining biological, physical, and chemical processes capable of producing and recycling the food, air, and water needed to enable long-term human missions in space in a safe and reliable manner while minimizing the need for resupply. SHF develops technologies that integrate the human and system elements of space flight and encourages mission planners to use human factors research results and technology developments to improve mission results and crew safety. AEMC develops new technologies, chemical and biological environmental sensors for air and water monitoring and microbial detection, as well as refining and micro miniaturizing currently available sensors.

Center Support

JSC is the lead center for implementing the AHST program. JSC coordinates all supporting center activities, manages ALS facilities, and conducts all system-level integration and testing for ALS. KSC manages extramural research and conducts specific research tasks directed at using plants in ALS systems. ARC manages extramural research and conducts specific research tasks directed at analytical models and physicochemical processes for ALS systems. JPL is the lead for the AEMC activities bringing their personnel and industry contacts to the development of sensors and monitoring capability.

MEASURES OF PERFORMANCE

The actual data reported is based on interim information available as of mid-December 1999. Complete 1999 data will be available in February 2000 with publication of the 1999 OLMSA Life Sciences and MR Program Tasks and Bibliographies annual report.

	FY 1999		FY 2000		FY 2001
	Plan	Actual (est.)	Plan	Revised	Plan
Number of Principal Investigations	70	70	77	77	84
Number of Co-Investigators Supported	138	168	152	160	165
Number of Refereed Publications	69	70	76	75	77

ACCOMPLISHMENTS AND PLANS

FY 99 Advanced Human Support Technology (AHST)

- **New Food Technology Center:** OLMSA established a new Food Technology Commercial Space Center in partnership with industry. The Center will perform research that could lead to better food for astronauts and safer, more nutritious, longer shelf life packaged foods for everyone.
- **Life support research facility construction:** OLMSA completed construction of the BIO-Plex facility at JSC, including construction and installation of the interconnecting tunnel and airlock for the four chambers and ground support utilities. NASA will use the facility to develop advanced human support technologies and systems to conduct biomedical, space medicine and human factors research.
- **Electronic Nose demonstrated in flight:** An Electronic Nose Flight Experiment successfully demonstrated an efficient, new approach to spacecraft atmosphere monitoring on STS-95.
- **Wireless Augmented Reality Prototype:** OLMSA completed an integrated Wireless Augmented Reality Prototype (WARP) technology demonstration. This technology will support improved communications, health monitoring, and training on the International Space Station through "virtual reality" technology. Several copies of these devices have already been acquired by the private sector.

In FY 2000 AHST plans to complete the first phase (including utilities outfitting of three test chambers) of the BIO-Plex facility which will provide the capability to conduct a series of long-duration, human-in-the-loop, advanced technology tests over the next six years. AHST will demonstrate key technology capabilities for human support such as advanced techniques for water processing using microbes, waste processing using biological degradation and fluidized bed incineration, a no-expendable trace gas contaminant control system, solid waste processing, and flight test a miniature mass spectrometer. A Commercial Space Technology Center will be established in the area of Environmental Systems.

In addition, in response to direction in the FY 2000 appropriation, AHST includes $0.915M to the "Garden Machine Program" at Texas Tech University. The "Garden Machine" is a small, environmentally controlled and monitored plant growth chamber, developed by NASA ARC, and transitioned to Texas Technological University (TTU) by NASA JSC.

In FY 2001, NASA will release the annual AHST NRA and expand ground research to prepare to take advantage of the growing ISS capability. Candidate technologies, including sensor technologies, for the BIO-Plex facility will be selected and the major test support systems buildup will continue. An engineering breadboard/prototype of a Vapor Phase Catalytic Ammonia Removal water

recovery subsystem will be developed for integrated evaluation at JSC. A flight test of the Immobilized Microbe Microgravity Water Processing System will be conducted. A Preliminary Design Review for the ISS Integrated AHST Facility will be conducted. Ground tests of Space Human Factors equipment, including the Wireless Augmented Reality Prototype, will be conducted.

BASIS OF FY 20001 FUNDING REQUIREMENT

BIOMEDICAL RESEARCH AND COUNTERMEASURES

	FY 1999	FY 2000	FY 2001
	(Thousands of Dollars)		
Biomedical Research and Countermeasures (BR&C)	59,700	57,192	76,900
Construction of Facilities	[3,500]	[9,000]	[8,500]
Minority University Research and Education Program	[1,000]	[1,000]	

GOALS

The goals of BR&C are to conduct research that (1) defines and reduces risk to crew health from space radiation; (2) defines and reduces risk of acute and chronic health problems, including psychological and behavioral problems; (3) will increase crew productivity in flight, and ensures crew resumption to full, healthy life on Earth; and (4) transfer biomedical knowledge and technology gained through research on the ground and in space to the Earth-based medical community.

STRATEGY FOR ACHIEVING GOALS

BR&C includes research on physiology, behavior and performance, biomedical countermeasures, operational and clinical problems, environmental health, and radiation health. BR&C is the primary OLMSA discipline for the Bioastronautics initiative, receiving the bulk of the Bioastronautics funding, in order to expand teams and task activities in the National Space Biomedical Research Institute (NSBRI). BR&C seeks to characterize and determine the mechanisms of physiological changes in weightlessness, including those that threaten to limit the duration of human space missions. It also develops methods that allow humans to live and work in microgravity, optimize crew safety, well being and performance, and minimize the deleterious effects of returning to earth's gravity after space flight. It 1) provides scientific knowledge required to specify, measure, and control spacecraft environments; 2) develops standards and countermeasures, where necessary, to optimize crew health, safety, and productivity; (3) develops monitoring techniques, procedures, and standards for extended missions; and (4) establishes the scientific basis for protecting humans engaged in the development and exploration of space from radiation hazards.

Center Support

JSC is the Lead Center for implementing the BR&C Program. ARC and KSC provide supporting center activities to JSC. JSC also manages the significant ground-based grant activities and all flight experiment activities focused on human research. ARC supports biomedical research investigations and plays the primary life sciences role in the development of biomedical flight experiments that require non-human subjects. KSC provides pre- and post-flight support for BR&C flight experiments. A countermeasure-focused research program is managed by a cooperative agreement between NASA JSC and Baylor College of Medicine. This cooperative agreement established the National Space Biomedical Research Institute (NSBRI), as a seven university consortium managed by Baylor College of Medicine and JSC, to accomplish integrated, critical path biomedical research and

countermeasures development. The NSBRI will play an important role in the Bioastronautics Initiative, providing a direct link to many of the nation's top biomedical research universities. The NSBRI expanded its team in FY2000 from seven to twelve consortium members. This expansion results in an increase from eight to twelve research discipline teams. The four new teams are cross-cutting integrative research disciplines.

MEASURES OF PERFORMANCE

The actual data reported are based on interim information available as of mid-December 1999. Complete 1999 data will be available in February 2000 with publication of the 1999 OLMSA Life Sciences and MR Program Tasks and Bibliographies annual report.

	FY 1999		FY 2000		FY 2001
	Plan	Actual (est.)	Plan	Revised	Plan
Number Principal Investigations	157	183	185	189	224
Number of Co-Investigators Supported	277	322	325	330	365
Number of Publications	285	332	335	343	375

ACCOMPLISHMENTS AND PLANS

FY 1999 included the flight of STS-95, a dedicated space shuttle research mission to conduct research in the life and microgravity sciences, including some exploratory research on aging and space flight. (A January 2000 symposium reported the preliminary results of STS 95.) OLMSA researchers also convened to conduct a one-year post-flight review of results from the Neurolab Space Shuttle mission. Preparations continued for STS-107, OLMSA's next major Space Shuttle flight opportunity, which will be dedicated to health and safety. Seven biomedical experiments have already been selected for STS-107. The BR& C released its annual NASA Research Announcement (NRA.) Genomic instability research continues to be jointly funded by the NASA space radiation health project and the National Cancer Institute. Construction of the Booster Applications Facility (BAF) at Brookhaven National Laboratory was started. In cooperation with Loma Linda University and Brookhaven National Laboratory, OLMSA researchers used the Loma Linda Proton Beam Facility and Brookhaven Heavy ion accelerators to simulate space radiation for radiation health research experiments. In FY 1999 Loma Linda University initiated development of a neurosciences research task. International collaboration in space radiation health involved 1) work with the Italian Space Agency to develop joint use of ground-based facilities, 2) participation by NASA investigators in research at the HIMAC facility of the National Institute of Radiological Sciences in Chiba, Japan, and 3) participation in the development of consensus recommendations to the Multilateral Medical Operation Panel for radiation protection on the ISS. An integrated Critical Path Research Plan was developed outlining a biomedical risk-based mitigation strategy for defining research requirements and selecting research to support future successful long-duration human space flights.

FY 2000 will include final preparations for initial research on the ISS. The Crew Health Care system and the first rack of the Human Research Facility will be deployed to the International Space Station and OLMSA will begin initial operations of these facilities. BR&C will release its annual NRA. Beginning in FY 2000 OLMSA is enlarging the role of the National Space Biomedical

Research Institute (NSBRI) to strengthen countermeasure development and improve the safety and performance of flight crews. The Radiation Research Instrument for Mars 2001 mission to study transit, orbital, and surface radiation effects will be completed.

Additionally per Congressional direction in FY 2000, BR&C will provide $3.661M to the Space Radiation Program at California's Loma Linda University Hospital and $1.831M to the Neutron Therapy Facility at Fermilab in West Chicago, Illinois. Loma Linda has received directives of more than $20M in the past four years to develop the beam line and proton facility, outfit laboratory space and support staff positions. The FY 2000 directive funds facility operations, which includes support of OLMSA's space radiation health program. The Neutron Therapy Facility is an independent medical group located at Fermilab in Illinois. This directive provides initial funding to change and develop a technology transfer center to promote commercial uses for federal research technologies developed by NASA and DoE. OLMSA disclosed in the initial FY 2000 operating plan the funding from within the baseline BR&C program budget to be used towards the Booster Applications Facility (BAF) construction at Brookhaven National Laboratory. BAF was included in the summer update to the FY 1999 operating plan. The BAF will provide the capability to simulate all major ion components and energies of galactic cosmic rays and solar proton events. Once the BAF becomes operational, Brookhaven National Laboratory will provide NASA access to more that 2,000 beam-hours –per year in order to meet all of the goals of the NASA Strategic Radiation Health Plan.

In FY 2001, OLMSA will continue to expand research operations on the ISS. The Office is preparing a wide range of experiments for flight on the International Space Station in FY 2001 and developing an expanded research program to take full advantage of growing ISS capabilities in the future. Facilities for human research and the Microgravity Science Glove Box will be available to support this research as part of the continuing deployment of the ISS. OLMSA has plans to participate in the Mars Surveyor Program 2001 orbiter and lander missions and the Mars 2003 mission. Specific details of planned participation may be revised, pending the outcome of Mars planning reviews by the Office of Space Science. The BR & C program will release its annual NRA. Also, the Booster Application Facility (BAF) construction progresses towards completion for operational research beginning in FY 2002.

BASIS OF FY 2001 FUNDING REQUIREMENT

FUNDAMENTAL BIOLOGY

	FY 1999	FY 2000	FY 2001
	(Thousands of Dollars)		
Fundamental Biology (FB) (Formerly Gravitational Biology and Ecology (GB&E))	40,900	38,200	39,200

GOALS

The goals of Fundamental Biology are to: (1) determine the mechanisms by which the evolution, development, structure, and function of cells, physiological systems, organisms and ecosystems sense and respond to gravity; (2) develop knowledge to support human space flight via countermeasures and bioregenerative life support systems; and (3) transfer biological knowledge and technology gained through research on the ground and in space to the medical and scientific communities.

STRATEGY FOR ACHIEVING GOALS

Investments in Fundamental Biology will improve understanding of the role of gravity in biological processes by using a variety of gravitational environments as research tools or by determining the combined effects of gravity and other environmental factors on biological systems. The emphasis is on research in cell and molecular biology, evolutionary and developmental biology, and organismal and comparative biology. Its research includes plants, animals, or other organisms as subjects, as well as cell or tissue cultures. The disciplines supported are Physical Interactions, Cellular and Molecular Biology, Evolutionary Biology, Developmental Biology, Plant and Comparative Biology, Global Monitoring and Disease Prediction, Gravitational Ecology and other outreach activities.

Center Support

ARC is the Lead Center for implementing the Fundamental Biology (FB) program, with other centers used to administer tasks or for their unique expertise. KSC provides pre- and post-flight support for FB flight experiments. A key collaborative venture between NASA and the National Institutes of Allergy and Infections Diseases is the use of remote sensing technologies for the prediction and control of global vector-borne human disease.

MEASURES OF PERFORMANCE

The actual data reported is based on interim information available as of mid-December 1999. Complete 1999 data will be available in February 2000 with publication of the 1999 Annual Report or the OLMSA Life Sciences and Microgravity Research Program Tasks and Bibliographies.

	FY 1999		FY 2000		FY 2001
	Plan	Actual (est.)	Plan	Revised	Plan
Number of Principal Investigations	153	171	157	166	164
Number of Co-Investigators Supported	175	176	180	181	177
Number of Publications	300	318	310	320	317

ACCOMPLISHMENTS AND PLANS

During FY 1999, efforts to restructure and expand the scope of FB consistent with the NASA and HEDS strategic plans continued. This included the initiation of a program name change request from Gravitational Biology and Ecology (GB&E) to Fundamental Biology (FB). New research proposals were awarded. An integrated research activity in evolutionary biology was begun and investigations selected and awarded. Data from Neurolab flight experiments to define the time course of adaptations in the balance system to altered gravitational environments and to compare the responses of at least three different biological models to understand the influence of gravity on the normal development of the nervous system were analyzed and published. Data from research carried out on MIR were analyzed and the research results will allow a one year “jump start” for ISS fundamental biology in the area of plant biology.

During FY 2000, FB flight experiments will provide information on the effects of exposure to microgravity on plant growth and development, and information to determine the effects of gravity on plant photosynthesis and respiration. Flight experiments on the effects of microgravity on avian development will be initiated. The FB program office will release its annual NRA. Collaborative efforts are also funded in the Space Sciences program under the Astrobiology program.

During FY 2001, funding for FB will enable expansion of support to approximately 164 investigations. Published abstracts and reports of progress for over 90% of FY 2000 research investigations (tasks) will be publicly available on the Internet. A wider range of investigations in fundamental biology will be supported. FB will increase fundamental knowledge in biological and biomedical sciences and address critical questions in crew health and safety by conducting 6 to 10 ISS investigations. These will include continued investigations on the effects of gravity on plant growth and physiology, providing information on the effect of the space environment on bacterial virulence and providing information on the effect of microgravity on skeletal myofibers. Fundamental biology research will also be conducted on the STS-107 Research Module mission, including studies of cells, plants, and rats.

BASIS OF FY 2001 FUNDING REQUIREMENT

MICROGRAVITY RESEARCH

	FY 1999	FY 2000	FY 2001
	(Thousands of Dollars)		
Microgravity Research (MR)	113,700	108,800	129,260

GOALS

Microgravity Research (MR) seeks to use the microgravity environment of space as a tool to advance knowledge, to use space as a laboratory, to explore the physical foundations of natural processes, contributing to progress in science and technology on Earth; and to study the role of gravity in technological processes, building a scientific understanding of the consequences of gravitational environments beyond Earth's boundaries.

STRATEGY FOR ACHIEVING GOALS

The MR strategy for achieving these goals includes: sustaining leading-edge research focused in the areas of biotechnology, combustion science, fluid physics, fundamental physics, and materials science that effectively engages the national research community; fostering an interdisciplinary community to promote synergy, creativity and value in carrying out the research; enabling research through the development of an appropriate infrastructure of ground-based facilities, diagnostic capabilities and flight facilities/opportunities; promoting the exchange of scientific knowledge and technological advances among academic, governmental and industrial communities and disseminating the results to the general public and to educational institutions; raising the awareness of the microgravity research community regarding the long-term direction of the Human Exploration and Development of Space (HEDS) enterprise; and discussing with the community the role of microgravity research in support to agency objectives. Finally, MR will continue to support the NASA/National Cancer Institute (NCI) collaborative program to define the opportunities and research directions to advance the development of technologies and informational tools needed to enable minimally-invasive detection, diagnosis, and management of disease and injury. MR will contribute to the Bioastronautics Initiative with continued support to the NASA/NCI collaboration activities and will identify and improve spacecraft environment, habitability and crew health.

CENTER SUPPORT

MSFC is the Lead Center for MR, delegating management of specific science disciplines and associated hardware development to GRC, JPL, JSC, and MSFC. All Centers provide pre- and post-flight support for MR flight experiments. The National Center for Microgravity Research on Fluids and Combustion, a joint cooperative agreement between the Universities Space Research Association, Case Western Reserve University and GRC, leads a national effort to increase both the number and quality of researchers and to accomplish integrated, critical path research in microgravity fluids and combustion sciences. New National

Centers for Microgravity Research in Materials Science, and Fundamental Physics are in the formulation phase with authority to proceed with the issuance of announcements of opportunity in FY 2000.

SCHEDULE AND OUTPUTS

The actual data reported is based on interim information available as of mid-December 1999. Complete1999 data will be available in February 2000 with publication of the 1999 OLMSA Life Sciences and MR Program Tasks and Bibliographies annual report.

	FY 1999		FY 2000			FY 2001		
	Plan	Actual (est.)	Plan	Revised		Plan	Revised	
Number of Principal Investigations	344	472	543	546	514	480		
Number of Co-Investigators Supported	395	540	600	600	560	530		
Number of Publications	1420	1950	2140	2140	2000	1900		

ACCOMPLISHMENTS AND PLANS

During FY 1999, Microgravity Research (MR) funding provided for the conduct of broad, productive Earth-based and space-based research. Based on research from the STS-90 mission, new genes were expressed for the first time under microgravity conditions in the Bioreactor. This research reveals that the microgravity environment of space fundamentally affects cellular processes and alters gene expression. It also represents the first application of recently developed gene array techniques to understand changes in cellular function in space. Exciting fundamental research results from fluid physics colloids experiments were obtained on STS-95. The Colloidal Gelation Experiment yielded insight into the formation of gels, a near rigid network of particles. This work is the essential first step in the synthesis of new materials from colloidal particles. The Colloidal Order-Disorder Transition Experiment yielded insight into the physics of the structure of materials at the atomic scale. Colloid systems are used to macroscopically model particle interactions at the atomic level.

Spacecraft Fire Safety data were verified through cooperative US/Russian MIR experiments. The flammability of selected U.S.-supplied plastic materials was tested under microgravity conditions in a Russian combustion tunnel operated on the *Mir* Orbital Station. The data was compared to reference testing of the flammability, heat release, thermal properties, and combustion products of identical materials in ground laboratories at both the Russian Keldysh Research Center and the NASA JSC White Sands Test Facility. Spacecraft radiation safety was advanced with an understanding of the fundamental processes and appropriate materials associated with shielding of spacecraft from space radiation. Progress includes development of a transport computer modeling code and of a nuclear database for evaluation of spacecraft shielding. This database consists of 75 important materials which are under characterization according to their shielding properties. An understanding of the production of neutrons due to collisions with spacecraft shielding materials has also been developed.

Optical particle manipulation techniques developed for colloids research, called laser tweezers and scissors, are being applied to In-vitro Fertilization Research at University Hospitals in Cleveland, OH. Interest in using the tweezers as a non-contact method for manipulating gametes and embryos in the laboratory prompted the collaboration. In addition, cell fusion studies using laser tweezers and scissors, may be performed by bringing two cells into contact and ablating the cell wall where they touch. Based on the early feasibility studies in the relevant fields, the collaboration is initially focusing on fusion studies.

Technology research in fundamental physics with the Magneto Optical Trap feasibility ground demonstration was successfully completed. This technology will enable significant increases in the accuracy of timekeeping and more generally enable a broad range of general relativity experiments utilizing the microgravity environment. The technology has been baselined for upcoming Fundamental Physics research on the ISS.

The program's continuing focus on communicating and interacting with the industrial sector resulted in receipt of initial recommendations from an Industrial Liaison Board, formed through an initiative of the National Center for Microgravity Research on Fluids and Combustion (NCMR), and convened by Dr. William Ballhaus, Vice President of Lockheed Martin Corporation. The board made recommendations on how NASA could enhance the value of its research on Microgravity Fluids and Combustion Research to the industrial sector.

In FY 1999, MR funding supported seven exploratory investigations in biology-inspired research. These investigations are the genesis of a research topic that will open new areas of technological development having tremendous impact on the efficient exploration of the near-Earth environment using the International Space Station, support future human exploration of space, and have a beneficial effect on the quality of life on Earth. This biology-inspired research involves smaller systems or machines with lower power requirements and much greater capability.

In FY 2000, MR funding is being used to continue preparation of upcoming ISS flight research, perform focused research activities on the STS-107 Research Mission, and conduct three investigations using suborbital rockets. Initial research deployment of Protein Crystal Growth experiments will begin on ISS on Flight 4A in the second half of CY 2000. Continued development of the ISS Fluid and Combustion Facility and Materials Science Research Facility will occur with Critical Design Reviews being conducted. Research needed to generate low-gravity technology required to advance human exploration of the solar system will be expanded. New research investigations will be selected in materials science in preparation for the deployment of major and sophisticated research apparatus aboard the ISS.

The mission integration and science program functions for the Alpha Magnetic Spectrometer (AMS) experiments are provided for as part of NASA's efforts in Fundamental Physics. This investigation is a collaboration of NASA and the Department of energy, and represents an international effort led by Nobel laureate Professor S.Ting to perform accurate and long-duration measurements of energetic cosmic rays spectra in search of dark matter, utilizing the International Space Station.

MR funding provides for continued support of exploratory research in biology-inspired technologies, including issuance of a cooperative agreement notice for a virtual center in advanced biotechnology. This center will tie together the research results and provide broader distribution of results from this biologically-inspired research.

In FY 2001, MR funding will provide for continued development preparations for upcoming ISS flight research, focused research activities on the STS-107 Research Mission, and conduct of three investigations using suborbital rockets. Research deployment aboard the ISS will increase with six flights occurring, setting the stage for future full utilization. MR will deliver thirty-three payloads in FY 2001. The payloads will support research investigations in the areas of biotechnology (macromolecular and cell science), materials science, fluid physics, and acceleration measurement. Research needed to generate low-gravity technology required to advance human exploration of the solar system will continue expand and evolve. New research projects will be selected

in Combustion Science and Fundamental Physics. Early ISS utilization will expand with science investigations being conducted on the Microgravity Science Glovebox and Express Rack. An increasing number of investigations will be undergoing final engineering readiness reviews in preparation for deployment in the ISS science research facilities.

Additionally in FY 2001, MR funding will support the development of a second generation research announcement in biology-inspired technologies with the idea of bringing some of the more promising technologies to a point of maturity where they could be used to support NASA missions. The potential areas are the following: 1) extending the capabilities of human interactions with machines through enhanced computational capabilities or improved sensor and data-handling capabilities, and 2) use of new biological materials or structural concepts inspired by biological functions found in nature.

MR will support a NASA/NCI collaborative program to define the opportunities and research directions to advance the development of technologies and informatics tools needed to enable minimally-invasive detection, diagnosis, and management of disease and injury. The technological breakthroughs in these areas will enable the development of revolutionary systems needed to support common and unique objectives of NASA and NCI including medical monitoring and management, early disease detection and intervention, and scientific exploration on Earth and in space. In FY 2001, MR funding provides for management oversight of the DOE sponsored AMS mission including the Critical Design Review (CDR) and the first NASA integration hardware deliveries to the DOE/AMS payload developer. In FY 1999, management oversight of the AMS mission was funded under the Mission Integration program.

BASIS OF FY 2001 FUNDING REQUIREMENT

SPACE PRODUCT DEVELOPMENT

	FY 1999	FY 2000	FY 2001
	(Thousands of Dollars)		
Space Product Development (SPD)	15,400	14,400	13,600

GOALS

The Space Product Development (SPD) Program facilitates the use of space for development of commercial products and services (including appropriate supporting ground-based activities); couples NASA and private sector technology development to the advantage of both; and incubates commercial enterprises that use space on a profit-making basis. The SPD Program also promotes the benefits of space-based research to industry, facilities industry's access to space, provides space research expertise and flight hardware, and advocates the development of policies to encourage commercial use of space.

STRATEGY FOR ACHIEVING GOALS

This program supports the operation of the NASA Commercial Space Centers (CSC), commercial flight research hardware for Shuttle and provides parabolic aircraft flight opportunity and program support to hardware funded by the Space Station office and developed for the International Space Station. The CSCs are partnerships of industry, universities, and local, state, and other federal agencies engaged in commercial space research. SPD encompasses a broad range of NASA efforts to encourage industry participation and investment in space. Commercial space research has the potential to create new or improved products, create jobs, give U.S. industry competitive advantages and improve the quality of life on Earth.

Center Support

The SPD program is managed by the Microgravity Research (MR) Program Office at the MSFC. The SPD program is primarily implemented through CSCs. Each CSC is a non-profit consortium of commercial and academic entities. Some also have government agency participation. The CSCs follow business leads and commitments to pursue product-oriented research in three major disciplines: materials research and development, biotechnology, and agriculture. NASA's role in this partnership is to provide leadership and direction for the integrated program and to provide the flight opportunities that are essential to the success of these efforts.

During FY 1999, in response to National Academy of Public Administration (NAPA) recommendations, the most promising of commercial research projects directly managed by the Space Product Development program at the Marshall Space Flight Center, were identified for possible transition to Commercial Space Centers. The long-term objective is to foster a more direct link between research planning and the private sector's investment in that research. The Space Product Development team plans to complete the transition of NASA commercial projects to the Commercial Space Center in FY 2000.

The CSCs have a unique role in assisting private businesses to conduct space research. They demonstrate to industry the values of space research, and they provide expertise essential to the conduct of successful research in space. CSCs furnish an infrastructure that provides a cost-effective and efficient way for companies to conduct research in space. The CSCs initiate industry involvement: first, by identifying and investigating industry-led research areas of commercial promise; and, second, by assessing markets for these potential research opportunities. The businesses support the research effort with resources including cash and in-kind, such as technical expertise, research materials, personnel, ground facilities, and research hardware.
Throughout much of the past decade, the CSCs have been active research participants in Shuttle flight activity and have optimized their research opportunities. Building on research results from Shuttle missions, the CSCs are expanding their research goals and evolving hardware experiment infrastructure to take full advantage of the extended microgravity environment the International Space Station will offer.

MEASURES OF PERFORMANCE

The measures of performance for SPD program include the number of university and industry affiliates that are working with NASA in the commercialization of space and the amount of funding leveraged from non-NASA sources by the CSCs.

	FY 1999		FY 2000		FY2001
	Plan	Actual	Plan	Revised	Plan
Industry Affiliates	145	159	162	155	170
University Affiliates	68	68	80	74	80
Payloads Flown (Shuttle)	11	10	12	2	6
(ISS)	--	--	-	-	7
Non-NASA $M Leveraged	55M	51.2M	60.0M	51.2M	52M

ACCOMPLISHMENTS AND PLANS

In FY 1999, significant commercial research activity was conducted on Shuttle missions including STS -95 in October, 1998 and STS -93 in July, 1999. On STS 95 there were eight commercial research payloads: Aerogel, Commercial Generic Bioprocessing Apparatus (CGBA), BioDyn, Astroculture,™, Commercial ITA Biomedical Experiment (CIBX), Advanced Separation (ADSEP),

Commercial Protein Crystal Growth, and Microencapsulation Electrostatic Processing, with multiple experiment activities on several of the eight payloads noted. Substantial commercial research gains were achieved including the following:

- Antibiotic Production: BioServe Space Technologies, a NASA Commercial Space Center, and their industry partner, Bristol-Myers Squibb, used the CGBA apparatus to conduct research on the production of microorganisms of the antibiotic actinomycin D, used in conjunction with cancer treatments. BioServe and their industry partner achieved a 75% higher rate over comparable ground control experiments, providing new insights that may improve ground-based production of antibiotics and therefore reduce the cost of antibiotic development.

- Insulin Research: The Center for Macromolecular Crystallography, a NASA Commercial Space Center, in collaboration with The Hauptman Research Institute, grew large crystals of human insulin which yielded high quality data allowing the electrostatic (as opposed to geometric) structure to be determined. This science will be extremely useful in the development of improved insulin formulations for the treatment of diabetes.

In addition to commercial research advances through flight activity, several ground-based research efforts also met with success.

- Imaging Technology: The Center for Commercial Applications of Combustion in Space, a NASA Commercial Space Center, developed two specialized cameras for combustion research. The Center, along with its industry partner, Roper Scientific, are now marketing these cameras in the medical imaging field. This new technology will allow weak images to be pulled from strong backgrounds, such as when tumors have the same general color and lighting as surrounding tissues.

- Telemedicine Demonstration: Physicians and scientists from Yale University, in association with the Medical Informatics and Technology Applications Center, a NASA-funded activity, accompanied professional climbers on an expedition to Mt. Everest where they evaluated emerging technologies in medical monitoring that have substantial application for diagnostic purposes in human space flight. This is an essential ingredient for long-duration space missions, and for remote location diagnostic applications on Earth, such as disaster relief efforts and remote location health care.

In FY 1999 the Space Product Development office at NASA's Marshall Space Flight Center strengthened its program oversight and assessment capabilities through the addition of several new program managers. They are an important asset, augmenting the small but experienced Space Product Development staff already in place.

Also in FY 1999, NASA program managers in the Space Utilization and Product Development office worked with NASA's Office of General Counsel to release a document that provided guidance on intellectual property and the International Space Station: creation, use, transfer, ownership and protection. This document will be used to brief prospective commercial users of the International Space Station on the regulations governing intellectual property aspects of research associated with the International Space Station.

Throughout FY 2000, the Space Product Development office will continue support for commercial research in biotechnology, agriculture and materials processing. Several commercial payloads in the fields of materials research, protein crystal growth, and agriculture will undergo program and technical assessments in preparation for flight on STS 107, the next substantial opportunity for commercial space research. Commercial research hardware infrastructure development will continue for deployment in the upcoming ISS Utilization flights. The Medical Informatics Technology Applications Center, located in Virginia

Commonwealth University, will foster the establishment of a telemedicine hub in Western Europe. NASA will also target at least 30% of available Space Shuttle and ISS research capabilities for commercial researchers, per the U.S. Payload Utilization Planning guidelines.

During FY 2001, Space Product Development will have as its goal the expansion of commitment from the private sector to invest in commercial space, as evidenced by at least ten new, active industry partners to the Commercial Space Centers. There are presently 159 commercial affiliates associated with 10 Commercial Space Centers. NASA will continue to be proactive in the development of policies and plans that foster commercial endeavors. As access to space is a key factor in obtaining and maintaining commercial sector commitment to and investment in space for product research, Space Product Development will support planning and preparation for commercial space product research on the ISS and on Shuttle for flight opportunities as they become available.

BASIS OF FY 2001 FUNDING REQUIREMENT

HEALTH RESEARCH

	FY 1999	FY 2000	FY 2001
	(Thousands of Dollars)		
Health Research (HR)	[7,600]	[8,700]	11,300
Occupational Health Research (OHR)	[900]	[1,400]	[1,100]
Space Medicine Research (SMR)	[6,700]	[7,300]	[10,200]

Commencing in FY 2001, the previously separate Occupational Health Research and Space Medicine Research functional activities have been combined into one single budget structure entitled Health Research. The combination of Space Medical Research and Occupational health Research into Health Research focuses the Agency's health research and health care functions for its workforce under one program, the Office of Health Affairs, OLMSA. Research conducted under the revised program is expected to have potential applicability for both general employee health and the health of astronauts during space flight. For purposes of transition, provided below is the budget content described in the prior budget structure.

GOALS (OCCUPATIONAL HEALTH RESEARCH)

The goals of the Health Research program include 1) Under Occupational Health Research, to improve NASA's Occupational Health program effectiveness and efficiency.; and 2) that NASA complies with all Federal safety and health requirements.

STRATEGY FOR ACHIEVING GOALS

OHR funding provides for policy formulation and oversight of NASA-wide occupational and environmental health programs. The OHR function consists of several well-defined constituent activities including Occupational Medicine, Industrial Hygiene, Radiation Health, Physical Fitness, Employee Assistance Programs, Workers' Compensation, Nutrition and Food Safety, and Wellness and Health Education. Collectively, these constituent activities assure the well-being and productivity of the NASA work force. OHR has the primary responsibility for the control and elimination of harmful exposures of NASA employees to toxic chemicals and hazardous physical agents, for the prevention of occupational disease and injury, and the promotion of optimal health, performance and productivity. KSC is the Principal Center for OHR. Primary strategic elements include: annual program planning, comprehensive audits of occupational health programs throughout NASA, consolidation of services such as technical support and training program development, metric definition and compilation, program status reporting to NASA Senior Management, program standardization and automation; increased inter-center communication; quality assurance programs including clinic accreditation through the Joint Commission on Accreditation of Health Care Organizations and the Occupational Safety and Health Administration Voluntary Protection Program; technical support center augmentation; and a training program development. Health Research will be an integral discipline of the Bioastronautics Initiative providing advanced medical systems and health care system validation.

MEASURES OF PERFORMANCE

Agency Workers' Compensation Rates	Reduce the incidence of harmful stress in the workplace by developing and implementing supervisor-specific training for the identification and management of stress in the workunit. Develop and implement training on techniques for coping with stress for the individual employee.
Agency Wellness programs	Begin a robust audit program of NASA Centers' occupational health programs, completing at least six (6) to ensure quality and continuous improvement of medical care and services including medical and environmental monitoring efforts, preventive services, emergency response capability, stress management efforts, and clinical intervention capability.

ACCOMPLISHMENTS AND PLANS

During FY 1999 OHR conducted two series of continuing education video-conferencing seminars on Bioethics and Health Surveillance and Maintenance in the Workplace and broadcast them to the Institute of Biomedical Problems in Moscow, the Commercial Center for Medical Informatics and Technology at Virginia Commonwealth University, other select academic institutions within the U.S., and all NASA centers. The benchmarking of OHR activities was expanded to include world class private industry organizations, selected through the American Productivity and Quality Control (APQC). A streamlined process verification of Center OHR activities was implemented. Formal collaborations with the Center for Disease Control and Prevention (CDC) and the American Heart Association were investigated for potential collaborative use of the HERO database and development of an outcomes-based Health Risk Appraisal instrument. An Occupational Health technical support center was established. An on-line support network of Agency resources on critical occupational health issues was implemented. Development of web site training modules for Employee Assistance topics was initiated with a module for all supervisors. Inter-agency agreements were continued to effect cost savings and to deliver specific subject matter expertise to all NASA Centers. NASA signed its initial agreements with the Joint Commission for the provision of clinic accreditation services.

During FY 2000, OHR will continue the series of professional education ViTS seminars starting with a series on Emerging Infectious Diseases. The series will be broadcast to the Medical Informatics and Technology Applications Consortium, Medical College of Virginia, the Institute of Biomedical Problems in Moscow, the European Institute of Telemedicine in Toulouse, France, other select academic institutions within the U.S., and all NASA centers. These series will also be available on the Internet for viewing on a desktop computer. A new comprehensive audit system is under development and will be deployed to 50% of the NASA locations each year. The Principal Center will complete a study to identify the feasibility of contract consolidation across the Centers. A pilot study utilizing the National Depression Screening Project will be completed. A new contract for providing after-hours employee assistance program coverage to all NASA facilities will be implemented. Two key NASA sites will initiate clinic accreditation through JCAHO. New Agency level metrics on skin cancer prevention, wellness and early diagnosis and intervention in disease will be instituted.

During 2001, OHR will continue emphasis on quality assurance for its occupational health program through implementation of clinic accreditation, certification of safety and health programs under the Occupational Safety and Health Administration Voluntary Protection Program, continuing professional education series, internal auditing and possible contract consolidation. Emphasis will also be placed on teaming with other Federal agencies for the delivery of services in a cost-effective manner. Wherever subject matter expertise can be obtained through inter-agency agreements, those agreements will be effected. Existing programs for technical center operation, program auditing, program standardization, senior management program reporting and advocacy, regulatory agency liaison, and oversight of the NASA occupational health function will be continued.

GOALS (SPACE MEDICINE RESEARCH)

The goals of Space Medicine Research (SMR) are (1) to ensure the health, safety, and performance of space flight crew members on all U.S. missions: Space Shuttle, the ISS, and the exploration missions; and (2) define and establish the requirements for clinical care and medical research.

STRATEGY FOR ACHIEVING GOALS

Within SMR, there are five elements that need to be tightly integrated: mission support for the Shuttle and ISS Program; astronaut health care; epidemiology (longitudinal studies of astronaut health); Crew Health Monitoring and Risk Mitigation (CHMRM); and Clinical Care Capability Development Program (CCCDP). The policies and requirements are developed to maintain and provide medical support to optimize the health, safety and productivity of our astronauts in space. This also includes technology and application developments. SMR funding provides for guidance and oversight of the medical operational support for human space flight and astronaut health care. SMR's scope ranges from the development of astronaut health policies, standards, and requirements for medical operations and medical research as well as the implementation of these requirements through operational medical support for all human space flight programs.

Center Support

JSC is the Lead Center for SMR. JSC manages clinical medical and psychological support of the astronauts as well as telemedicine efforts in support of medical operations activities for the Human Space Flight (HSF) Program. The major participating academic institutions are Wright State University School of Medicine, Medical College of Virginia at the Virginia Commonwealth University, and the University of Texas Medical Branch at Galveston.

MEASURES OF PERFORMANCE

Crew Health Care System Plan: 2nd Qtr 00 Actual: 3rd Qtr 99	Develop protocols and test the capability of the CHeCS as integrated into the ISS.

ACCOMPLISHMENTS AND PLANS

During FY 1999, NASA contracted with the Joint Commission Resources (a consulting group formed to do the review for accreditation) to provide an analysis of the current state of NASA's Health Care Delivery System and what actions would be needed for the system to receive accreditation. In addition, the National Academy of Sciences (NAS), Institute of Medicine (IOM) began a two year study of what actions need to be taken for the Space Medicine Program to be able to fully support long duration human space missions in low Earth orbit and beyond. The CHMRM program was developed to provide and integrate health management: clinical services, medical monitoring, preventive countermeasures, and clinical medical research, to help ensure the health and safety of ISS crewmembers. CCCDP funding was used to evaluate and refine space flight medical requirements and procedures and to identify and develop technologies required for the delivery of inflight crew health care. CCCDP activities included evaluation of the Telemedicine Instrumentation Pack (TIP) on ground based missions in Montana and Texas, and the identification of technology development areas that will be key to delivery of effective medical care during long duration space flight. The Agency Strategic Plan for Telemedicine was implemented through partnerships with the NASA Centers and the Medical Informatics and Technology Applications Consortium (MITAC) at Virginia Commonwealth University. Epidemiology continued to examine the incidence of acute and chronic morbidity and mortality among astronauts to better define the medical risks associated with space flight.

During FY 2000, SMR funding provides continued support of the needs of the space medicine community for Shuttle missions including operational medical support for the ISS. CHMRM funding will assist in the development, monitoring and interpretation of operational health related data from space flight including: support of the implementation and interpretation of Medical Requirements (MRs) for STS and ISS, and IPT support of rapid responses to clinical studies relative to space medicine issues. ISS CHeCS components will be deployed early in the ISS assembly sequence to provide on-orbit medical, environmental, and countermeasure capabilities for all ISS crewmembers. CCCDP funding will support the ongoing evolution of space medicine requirements, procedures, and technologies. Plans will be developed to augment ISS CHeCS with new and emerging medical and environmental technologies, many of which will be in the process of development at the NSBRI. Epidemiological efforts will continue to evaluate the growing body of astronaut health data to better define the medical risks associated with space flight. Special emphasis will be placed on clinical medical research, radiation research and psychological/human factors.

During FY 2001, SMR funding will continue supporting the needs of the operational medicine community for Shuttle and ISS missions. Deliverables associated with the CHMRM will include Medical Assessment Tests (MATs), Medical Requirements Integration Documents (MRIDs) for each MR, clinical interpretation and reporting in collaboration with the crew flight surgeon, data delivery for archiving and later epidemiological evaluation, and health risk assessments as needed. Additional ISS CHeCS components will be utilized to provide on-orbit medical, environmental, and countermeasure capabilities for all ISS crew members. In-flight Shuttle and ISS medical capabilities will be augmented with new flight-proven technologies. Medical and environmental information gained from continuing CHMRM will be utilized to refine medical flight system requirements,

protocols, and procedures. CCCDP funding will provide impetus for the evolution of space medicine requirements, procedures, and technologies. Epidemiological efforts will continue to better define the human medical risks associated with space flight and the effectiveness of operational countermeasures in dealing with these risks. Special emphasis will continue in the areas of clinical medical practice, radiation and psychology/human factors.

BASIS OF FY 2001 FUNDING REQUIREMENT

MISSION INTEGRATION

	FY 1999	FY 2000	FY 2001
		(Thousands of Dollars)	
Mission Integration (MI)	1,700	17,214	240
(Life Sciences Research Facility)		[12,814]	

GOALS

The goals of Mission Integration (MI) are: (1) provide physical, analytical, and operations integration support for Human Space Flight missions, to achieve NASA mission objectives for the science and technology communities; and (2) ensure integrated scientific, technological, and commercial user advocacy and coordination of requirements for the next generation of space laboratories, the ISS. These activities include the integration, coordination and policy planning and analysis for International research activities within OLMSA.

STRATEGY FOR ACHIEVING GOALS

In order to meet the function goals and objectives, MI performs the space-based research utilization planning of all OLMSA Space Shuttle and ISS payloads. In addition, through this function, MI carries out systems engineering efforts to develop and evaluate strategies and processes for satisfying current and future research mission objectives. These tasks not only address the current human based space flight platform mission integration processes, but, based on this knowledge base, they define and support new effective and efficient processes and tools for carrying out integrated research advocacy, requirements coordination, mission planning and operations for future space platforms. In particular, the program is investigating ways to apply the engineering and operations lessons learned in the Spacelab program and the NASA/MIR Research Program (NMRP) to the ISS program to achieve greater efficiencies.

Center Support

Headquarters remains the Lead Center for planning and directing Mission Integration. The principal NASA Centers, which conduct activities in support of MI, are JSC, KSC, and MSFC. The JSC is the primary center for providing the mission implementation function for Headquarters research mission activities, and is responsible for monitoring the contract for SpaceHab Inc. the commercial carrier provider that has assumed the payload integration function post-Spacelab. SpaceHab provided payload management and integration for research payloads on the STS-95 Research Module mission in FY 1999, and will perform a similar function for the STS-107 Research Module mission scheduled for launch in early 2nd quarter FY 2001.

MEASURES OF PERFORMANCE

The most significant measure of MI performance is the provision of an integrated system that ensures successful accomplishment of the science payload objectives on Space Shuttle missions that carry OLMSA sponsored research. Although not directly responsible for the success of a particular experiment, MI is intrinsic for ensuring that all necessary planning and integration of the collected set of instruments have been comprehensively completed and fully coordinated so that the experimental hardware in concert with flight crew performance and ground control direction have the opportunity to conduct the planned science activities. Science payload objectives vary considerably depending upon the type of mission supported (module missions, pallet/MPESS missions or Space Shuttle Middecks) and the type of scientific investigations performed (microgravity, life sciences, Earth and stellar observations). Depending upon the type of payload, performance is characteristically measured and reported in terms of the actual science/research accomplishment vis-à-vis planned accomplishment specified by the anticipated on-orbit crew activity timeline. Another useful metric involves publications in peer science journals. The data usually lags a flight by two to three years because of data analysis and publication review and/or edit times.

	FY 1999		FY 2000		FY 2001
	Plan	Actual	Plan	Revised	Plan
SpaceHab/Pallet/Shuttle	1	1	1	--	1
Middecks/Small Payloads	4	6	--	5	--

ACCOMPLISHMENTS AND PLANS

During FY 1999, MI funding provided support for the completion of the STS-95 Research Module mission which flew Senator John Glenn. In addition, initial MI support was provided for defining a second research mission (STS-107) to provide a transition between the completed Shuttle research missions and the onset of significant research capability on-board the ISS. As with STS-95, this mission is intended to be a pathfinder for future commercial involvement in carrying out orbital research, and will be implemented through SpaceHab for the carrier and carrier integration services. This mission, which incorporates "lessons learned" from the STS-95 flight, is an Extended Duration Orbiter (EDO) (14-16 day) mission and is anticipated to fly in early 2nd quarter FY 2001. It is also the first flight of SpaceHab's Research Double Module (RDM), effectively doubling the upmass capacity for OLMSA related research compared to the prior STS-95 allocation. A proposed payload complement with thematic emphasis towards crew health and safety has been baselined. The manifest also includes several commercial-type small payloads. In FY 1999 the Alpha Magnetic Spectrometry (AMS) payload was used to conduct a post-flight assessment of the STS-91 mission, as well as initial planning for the next flight of AMS as an externally attached payload on the ISS.

Early in FY 1999 NASA examined plans for a "standby research mission", involving both new and reflown scientific research, which could be inserted into the Shuttle manifest if and when an ISS or Shuttle schedule anomaly occurred. However, this was shown to be a non-viable mission alternative with poor return on investment for PIs, payload equipment developers, and commercial payloads, because of the high cost of being in standby mode over a potentially long period of time.

During FY 2000, MI will continue support for the second DOE-sponsored Alpha Magnetic Spectrometry (AMS) mission planned for the ISS including the Preliminary Design Review (PDR) for integration on ISS and the initial safety reviews. Continuing Space Shuttle "pathfinder" research missions such as STS-107 will provide space access to the science and commercial programs until a

substantive research capability is available on the ISS. To offset some of the costs, SpaceHab again (similar to STS-95) has been allocated some of the carrier capability to market to non-NASA customers, including ISS partners who wish to take advantage of this research opportunity before they have access to ISS utilization.

Additionally, per Congressional direction in FY 2000, MI will supply funding of $12.814M for construction of a life sciences research facility at the University of Missouri, Columbia.

In FY 2001, MI will transfer management oversight in support for the DOE-sponsored AMS mission including the Critical Design Review (CDR) and the first NASA integration hardware deliveries to the DOE/AMS payload developer to Microgravity Research. The first Research Double Module (RDM) will be flown on STS-107. In the interim, science/research at the middeck locker equivalent (MLE) level will be flown on ISS assembly flights on a space-available basis.

P.L. 106-74 includes a limitation stipulating that $40 million of the amount provided for Human Space Flight "shall be available to the space shuttle program only for preparations necessary to carry out a life and micro-gravity science mission, to be flown between STS-107 and December 2001." The amounts earmarked within the FY 2000 Shuttle budget ($40 million) and amounts available in FY 1999 appropriations for Life and Microgravity Sciences and Applications ($10 million) fall considerably short of the funds needed to conduct a science mission, which ranges from about $137-166 million. A page on this issue is in the Special Issue Section.

BASIS OF FY 2001 FUNDING REQUIREMENT

INVESTMENTS

	FY 1999	FY 2000	FY 2001
	(Thousands of Dollars)		
Investments (MURED)	[1,000]	[1,000]	1,000

The Human Exploration and Development of Space (HEDS) Strategic Enterprise investments in higher education institutions include Federally mandated outreach to the Nation's Historically Black Colleges and Universities (HBCUs) and Other Minority Universities (OMUs), including Hispanic-Serving Institution and Tribal Colleges and Universities. This outreach is achieved through a comprehensive and complementary array of strategies developed in collaboration with the Office of Equal Opportunity Programs. These strategies are designed to create a broad-based, competitive aerospace research capability within Minority Institutions (MI's). This capability fosters new aerospace science and technology concepts by integrating HEDS Enterprise-related cutting-edge science and technology concepts, practices, and teaching strategies into MI's academic, scientific and technology infrastructure. As result, increasing the production of more competitive trained U. S. students, underrepresented in NASA-related fields who, because of their research training and exposure to cutting-edge technologies, are better prepared to enter graduate programs or the workplace. Other initiatives are focused on enhancing diversity in the HEDS Strategic Enterprise's programs and activities. This includes exposing faculty and students from HBCUs and OMUs, and students from under-served schools, with significant enrollments of minority students, to the Enterprise's research efforts and outcomes, educational programs, and activities. To support the accomplishment of the Enterprise's mission, these programs are implemented through NASA Centers and JPL. The Centers and JPL support the MUREP through use of their unique facilities, program management and grant administration, and commitment of their personnel to provide technical assistance and assist in other facets of program implementation. Extensive detail as to how this funding is utilized is located under the MUREP portion of the budget.